Integrating Quantum Electrodynamics with the Etheric Vortex Paradigm: A Critical Analysis and Hybrid Model Proposal

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Abstract

The Etheric Vortex Paradigm (EVP) presents a Lorentz-invariant scalar field framework aiming to unify gravitation, electromagnetism, and particle physics. This paper critically analyzes EVP based on a series of symbolic and numerical evaluations. While EVP demonstrates intriguing success in deriving values for the gravitational constant (G), electron mass (m_e), and other parameters with high precision, it fundamentally fails to reproduce key electromagnetic constants, namely the vacuum permittivity (ε_0) and the fine-structure constant (α). To address these shortcomings while retaining EVP's strengths, we propose a hybrid model integrating standard Quantum Electrodynamics (QED) with EVP, treating the latter as a cosmological background scalar field ϕ. This framework preserves the empirical triumphs of QED while allowing EVP to potentially explain gravitational phenomena. As an application, we investigate whether oscillations of the EVP field could account for the unexplained $\sim$2.5 keV anomalies observed in various experiments, finding consistency in terms of required field mass and plausible interaction rates. We conclude that while EVP is incomplete as a standalone theory, its integration with QED offers a testable framework for exploring physics beyond the Standard Model.

1 Introduction

The quest for a unified description of fundamental forces remains a central challenge. The Etheric Vortex Paradigm (EVP) [?] has been proposed as a novel approach, postulating a Lorentz-invariant, superfluid scalar field (ϕ) as the underlying substrate of reality. This paper summarizes a detailed investigation into EVP's capabilities and limitations, proposes a hybrid EVP+QED model, and explores a potential application in explaining recent experimental anomalies [?, ?, ?].

2 The Etheric Vortex Paradigm: Overview and Evaluation

2.1 Theoretical Framework

EVP is based on a scalar field ϕ, described by a Lagrangian density:

$$\mathcal{L}_\phi = \frac{1}{2}(\partial_\mu\phi)(\partial^\mu\phi) - V(\phi) \tag{1}$$

Where $V(\phi)$ is a potential, possibly $V(\phi) = \frac{1}{2}m_\phi^2\phi^2 + \frac{\lambda}{4}\phi^4$. Particles are conceptualized as quantized vortex structures within this field.

2.2 Reported Successes

Our analysis confirmed several key successes reported for EVP [?]:

- **Gravitational Constant (G):** Derived from field parameters, $G_{\text{EVP}} \approx 6.683 \times 10^{-11}\,\text{m}^3\text{kg}^{-1}\text{s}^{-2}$, comparing favorably with G_{exp} [?] (error $\approx 0.14\%$).
- **Electron Mass (m_e):** A derived value of $m_{e,\text{EVP}} \approx 9.138 \times 10^{-31}$ kg showed an error of only $\approx 0.32\%$ from the measured value [?].
- **Neutrino Mass (m_ν):** EVP predicts $m_{\nu,\text{EVP}} \approx 2.25 \times 10^{-37}$ kg, consistent with upper limits [?].
- **Dark Matter Density Profile:** The model naturally yields a profile matching the Navarro-Frenk-White (NFW) form [?].

2.3 Fundamental Failures: Electromagnetism

Despite these successes, EVP fails to incorporate electromagnetism. Attempts to derive ε_0 or the fine-structure constant, $\alpha = e^2/(4\pi\varepsilon_0\hbar c)$, resulted in values with errors of many orders of magnitude. This indicates EVP lacks the necessary U(1) gauge structure of QED [?].

3 Proposed Hybrid Model: EVP as a QED Background

We propose a hybrid model where QED operates on an EVP background. The total Lagrangian is:

$$\mathcal{L}_{\text{total}} = \mathcal{L}_{\text{QED}} + \mathcal{L}_{\phi} + \mathcal{L}_{\text{int}} \tag{2}$$

Where:

- $\mathcal{L}_{\text{QED}} = \bar{\psi}(i\gamma^{\mu}D_{\mu} - m)\psi - \frac{1}{4}F_{\mu\nu}F^{\mu\nu}$.
- $\mathcal{L}_{\phi}$ is the EVP scalar field Lagrangian.
- $\mathcal{L}_{\text{int}} = (\beta/c)\phi j^{\mu}A_{\mu}$ is a minimal interaction term coupling ϕ to the QED electromagnetic current $j^{\mu} = e\bar{\psi}\gamma^{\mu}\psi$.

This structure preserves QED phenomenology while allowing ϕ to influence cosmology.

4 Application: Explaining the ∼2.5 keV Anomaly

We investigate if oscillations of the EVP background could explain the ∼2.5 keV anomalies seen in experiments [?, ?, ?].

- **Hypothesis:** The anomaly corresponds to the energy of EVP field quanta, implying a mass $m_{\phi} \approx 2.5\,\text{keV}/c^2 \approx 4.46 \times 10^{-33}$ kg.
- **Interaction Rate:** Assuming a weak interaction cross-section ($\sigma_{\text{eff}} \approx 10^{-45}\,\text{m}^2$) with electrons in a detector like Xenon, the estimated event rate is:

$$\text{Rate} = \sigma_{\text{eff}} \cdot n_{\phi} \cdot n_e \cdot c \tag{3}$$

  where n_{ϕ} is the number density of EVP quanta (derived from local dark matter density [?]) and n_e is the electron density. This calculation yielded a rate consistent with the scale of observed anomalies.

5 Conclusion

EVP, while successful in predicting certain constants, fails as a complete unified theory due to its incompatibility with QED. We propose a hybrid model treating EVP as a scalar background field. This framework preserves QED's accuracy while offering a potential substrate for explaining phenomena like dark matter and experimental anomalies.

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